

Mobile Application for Analysing the Development of Motor Skills in Children [†]

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[†] Presented at the 3rd XoveTIC Conference, A Coruña, Spain, 8–9 October 2020.

Published: 26 August 2020

Abstract: This work presents a mobile application to complement and reinforce the specific physical activities in children through training prior to such activities and monitoring their progress after it. This experiment has been developed on a healthy population of children from an education centre in the area of A Coruña. The results show increasing errors for lower primary school years, as expected, and also strongly dependent on the motor path type or characteristic. Therefore, this tool will be suitable for use with children affected by motor coordination difficulties.

Keywords: data science; engine development; information systems; mobile app; motor coordination

1. Introduction

A child's motor development involves a sequential evolution from initial simple and disorganized movements to increasingly complex and organized movements [1]. However, in the stages of infant and primary schooling (3–6 years and 7–12 years, respectively), it is common to detect the need for educational reinforcement to improve the learning of these motor skills. Appropriate early intervention could correct some of these difficulties and contribute to the child's motor progress thus avoiding possible negative implications such as poor motor coordination [2]. This work presents a mobile application, referred to as simply app, for the analysis of the motor evolution in these children. This tool is useful for any professional directly involved with children's motor development, such as psychopedagogues, physiotherapists, occupational therapists and, of course, the children themselves [3]. The tool developed consists of the tactile tracking on the screen of the mobile device of an object that moves on different paths designed by an interdisciplinary team, made up of physiotherapists and computer specialists. The path characteristics and the object movement can be configured by the expert according to the initial assessment of each child and the periodic feedback received from the analysis of the data extracted using this application throughout different sessions. The app offers an objective information system that is indispensable for quantifying the child's progress through an adequate data registration, data export and a subsequent analysis that allows a detailed follow-up of the detected need. Moreover, the tool can be adapted to this evolution and to each individual need for reinforcement. Thus, aspects such as the path to be followed, the characteristics of this path, the type of object that moves on it, the speed factor of this object when moving on this path or the number of attempts, among others, can be configured, so that several levels of difficulty adapt

to the child's motor development. This app allows to easily manage users and record session results so that the therapist can perform a complete analysis considering different parameters such as accuracy and time.

This work is organized as follows: Section 2 presents materials and methods, Section 3 shows the main results obtained using this app, and Section 4 is devoted to conclusions.

2. Materials and Methods

The children sample was randomly selected among students from an education centre in the area of A Coruña involved in the program of detection and promotion of motor coordination for which the application was designed. Only those children who had not presented any problem at the motor level in the previous evaluations were included, with the aim of knowing the results of this software use on the general population of early school years (six primary school years, from 7 to 12 years, with 7–8 children per year). The app considers three difficulty levels associated with three movement paths (as shown in Figure 1) of increasing difficulty in terms of motor coordination i.e., straight line path, curved line path and zigzag line path. Each level is in turn subdivided into three modes according to the characteristics of these paths: slow speed (3 cm/s from first to third year and 4 cm/s from fourth to sixth year), fast speed (6 cm/s from first to third year and 8 cm/s from fourth to sixth year) and fast speed with disappearance of the moving object (with the same speeds as in the previous case).

The procedure for the experiment was the following. Firstly, we have to say that the evaluations on each subject were individually conducted by a physical therapist during Physical Education sessions. By moving an object along a path on the screen of the mobile device, as depicted in Figure 1, they could carry out the spatial prediction of movement activities to be then performed in those physical sessions. The tests were carried out in an empty classroom, with a relaxed sitting position and resting the mobile device, a tablet in this case, on a table. The estimated duration of the experiment per child was of 25 min, distributed as follows: the app was explained in the first 15 min, when was emphasized that the ball should be pressed on the screen to start each exercise and that the finger should not be separated from it at any time during the path to its end, all the levels and the different progressions of complexity within each one were explained, and the last minutes of this phase were devoted to practice the exercises of each level in a guided way, while in the final 10 min data was recorded until each child finished three complete repetitions with a permissible error doing all exercises contained in each of those 9 sub-levels of work.

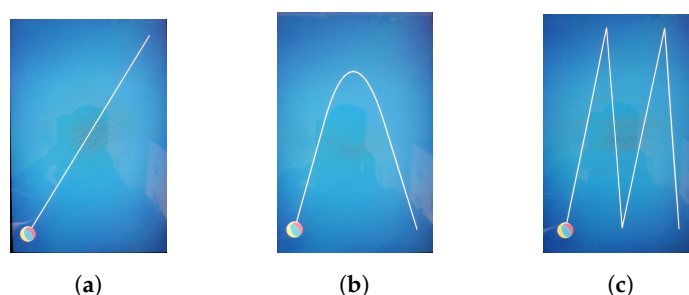


Figure 1. Types of movement paths: (a) Straight line path. (b) Curved line path. (c) Zigzag line path.

3. Results

From the data registered by our app, a first survey has been carried out considering motor coordination. An error measurement to quantify this skill is given by the euclidean distance between the path displayed on the mobile screen and what the user does, expressed in cm.

Figure 2a,c show box diagrams of the errors made by students of different primary school years for the three modes: slow speed, fast speed and fast speed without path display, respectively. The data corresponding to all different levels, i.e., the path types of Figure 1 and attempts made by each student,

have been grouped together. For all figures, a clear error decrease can be observed as the school year increases. Between the third and the fourth year the differences are less noticeable, due to the higher speed used for the same mode in the last three years. Moreover, the error always increases with the speed (Figure 2a,b) and even more when the path display is hidden (Figure 2c). Figure 3a,c show box diagrams for levels 1, 2 and 3, respectively corresponding to the paths depicted in Figure 1, this time grouping the data corresponding to the different modes and attempts of each student. In this case you can see how the errors increase when considering increasingly complex movement paths. Again, it is observed that the error decreases as the course increases, except between the third and the fourth primary school year, for the same reason as explained above.

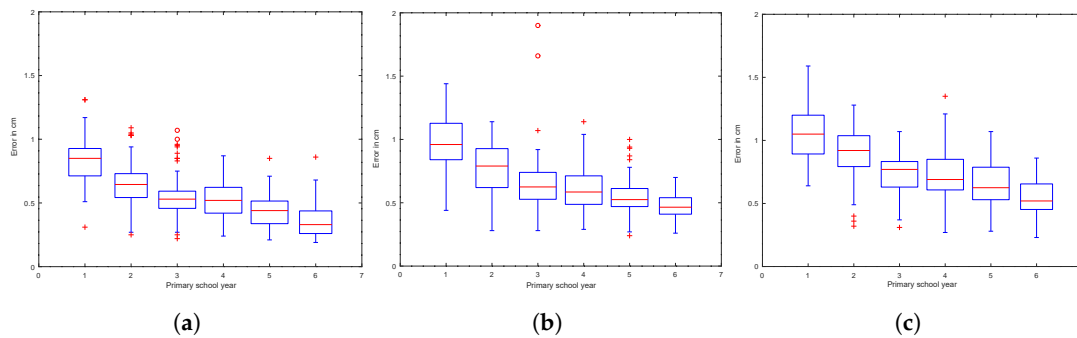


Figure 2. Motor coordination errors for three modes: (a) Slow speed. (b) Fast speed. (c) Fast speed without path display.

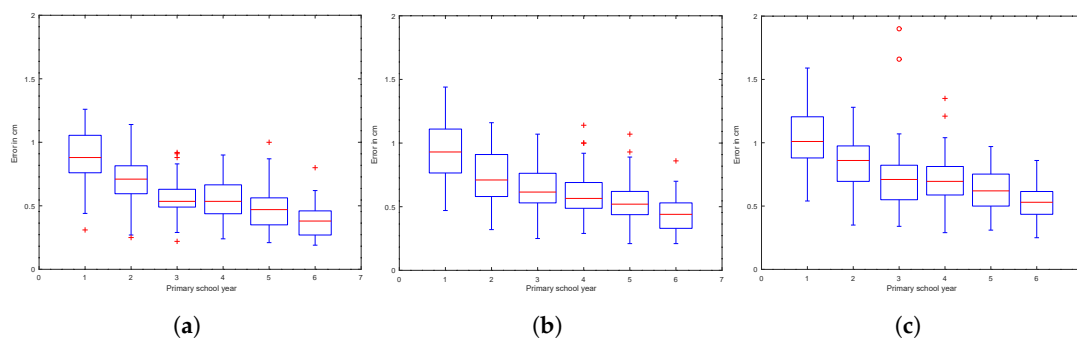


Figure 3. Motor coordination errors for three levels: (a) Straight line path. (b) Curved line path. (c) Zigzag line path.

4. Discussion and Conclusions

There are no similar tools designed for this purpose with which to compare these results. This application provides objective and measurable data on the accuracy and quality of the requested movement, which are ignored by current evaluation tools. In conclusion, it shows predictable behaviour in scenarios of healthy population, so that the following step is its use on children affected by motor coordination difficulties as support tool for their improvement and progress monitoring.

Author Contributions: F.J.V.-A. has implemented the app software; D.M.N. performed the experiments; D.M.N. and P.M.C. analyzed the data; J.V.C. and L.G.D. designed the experiments and P.M.C. and A.D. head the research.

Funding: This work has been funded by the Xunta de Galicia (ED431G2019/01), the Agencia Estatal de Investigación of Spain (TEC2016-75067-C4-1-R) and ERDF funds of the EU (AEI/FEDER, UE).

Conflicts of Interest: The authors declare no conflict of interest.

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